Alytes, 1996, **14** (3): 115-121.

Acanthocephala parasitic in North American amphibians: a review with new records

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Sixty-nine records of Acanthocephala in North American amphibians are reviewed. In North America, nine adult and two cystacanth Acanthocephala species in six genera have been recorded from 29 amphibian host species. Most reports are from aquatic hosts. Acanthocephala in four of these genera are considered accidental infections. Cystacanths of *Centrorhynchus* species and certain adult *Fessisentis* species are the only regular acanthocephalan parasites of North American amphibians. New host records for *Fessisentis friedi* in *Rana pipiens* and *R. catesbeiana* and *Neoechinorhynchus rutili* in *R. catesbeiana* collected in New Brunswick, Canada, are additional to the previous single report of an adult acanthocephalan parasitic in a North American anuran. In North America, larval Acanthocephala occur in both salamanders and frogs. Adult Acanthocephala in North American amphibians most frequently parasitize aquatic salamanders and only parasitize anurans accidentally. This is in contrast to European amphibians where adult *Acanthocephalus ranae* is common in both salamander and frog helminth communities and acanthocephalan cystacanths have been infrequently recorded as amphibian parasites.

Acanthocephalans are infrequent and relatively uncommon parasites of North American amphibians, although several species, most notably *Acanthocephalus ranae* (Schrank, 1788), are common to such hosts in Europe. In this note, I review the scattered reports of Acanthocephala from amphibians in North America and present new records of Acanthocephala parasitic in bullfrogs, *Rana catesbeiana*, and leopard frogs, *R. pipiens*, collected in New Brunswick, Canada. Acanthocephalan specimens on which new records are based have been deposited in the collections of the New Brunswick Museum.

The earliest report of Acanthocephala parasitic in North American Amphibia is that of Stiles & Hassall (1894), who recorded *Echinorhynchus* sp. from *Notophthalmus viridescens*, the red-spotted newt, collected in Maryland Van Cleave (1915) later identified the seven specimens in this collection as *Acanthocephalus ranae*, a species typical of European amphibians. McAlpine (in press) has re-identified this material as *Acanthocephalus dirus* (Van Cleave, 1931). Holl (1932) commonly encountered an acanthocephalan in the aquatic adult stage of the red-spotted newt which was subsequently described by Van Cleave (1931) as *A acutulus*. McAlpine (in press) demonstrated that these worms belong to the genus *Fessisentis* and should be referred to as

Table I - Records of Acanthocephala from North American Amphibia The use of the terms prevalence, intensity (range), and abundance follow MARGOLIS et al (1982) Where reported sample size for hosts is shown in parenthesis Age class of hosts is noted as larvae (*), larvae and adults (*+) or adults (+)

Species	Age class	Host	Location	Prevalence	Intensity*/ Abundance◆	Source
Acanthocephala sp	cystacanth	*Rana sylvatica* +	Ohio	?	?	ODLAUG (1954)
Acanthocephala sp	cystacanth	*Desmognathus brimleyorum* + (13)	Arkansas	8%	1*	WINTER et al. (1986)
Acanthocephala sp	cystacanth	*Desmognathus brimleyorum* + (41)	Arkansas	2%	1*	MCALLISTER et al (1995a)
Acanthocephala sp	cystacanth	*Desmognathus fuscus* + (16)	North Carolina	31%	1 37◆	MANN (1932)
Acanthocephala sp	cystacanth	*Desmognathus fuscus* + (16)	North Carolina	12 1%	0 53◆	MANN (1932)
Acanthocephala sp	cystacanth	*Desmognathus fuscus* +	North Carolina	3 01%	0 04◆	RANKIN (1937)
Acanthocephala sp	cystacanth	*Desmognathus fuscus* +	North Carolina	3 03%	0 06◆	RANKIN (1937)
Acanthocephala sp	cystacanth	*Desmognathus quadramaculatus* + (46)	North Carolina	0 02%	0 06◆	RANKIN (1937)
Acanthocephala sp	cystacanth	*Plethodon albagula* + (37)	Arkansas	3.0%	1*	MCALLISTER (1993)
Acanthocephala sp	cystacanth	*Plethodon glutinosus* + (20)	North Carolina	5.0%	0.20◆	MANN (1932)
Acanthocephala sp	cystacanth	*Plethodon glutinosus* + (39)	North Carolina	2 5%	0 10◆	MANN (1932)
Acanthocephala sp	adult	*Ambystoma opacum** (18)	North Carolina	31 2%	0 62◆	RANKIN (1937)
Acanthocephala sp	adult	*Desmognathus fuscus**	North Carolina	4 9%	0 09◆	RANKIN (1937)
Acanthocephala sp	adult	*Desmognathus fuscus* +	North Carolina	5 4%	0 07◆	RANKIN (1937)
Acanthocephala sp	adult	*Desmognathus fuscus* + (442)	Illinois	1 1%	0 01◆	DYER et al (1980)
Acanthocephala sp	adult	*Eurycea multiplicata* +	Arkansas	7 1%	2*	FOGLE (1960)
Acanthocephala sp.	adult	*Notophthalmus viridescens* +	North Carolina	3 7%	0 11◆	RANKIN (1937)
Acanthocephala sp.	adult	*Plethodon glutinosus* +	North Carolina	3 4%	0 06◆	RANKIN (1937)
Acanthocephala sp	adult	*Plethodon jordani* + (195)	North Carolina	1 2%	1*	DYER (1983)
Acanthocephala sp	adult	*Siren intermedia* + (2)	Missouri	50 0%	5	DYER & RANDON (1973)
Acanthocephalus sp.	adult	*Ambystoma talpoideum* + (2)	Illinois	50 0%	8*	LANDEWE (1963)
Acanthocephalus sp	adult	*Amphiuma tridactylum* + (85)	Louisiana	1 2%	1*	BENNETT & HUMES (1938), WALTON 1942
Acanthocephalus sp.	adult	*Plethodon glutinosus* + (67)	Louisiana	1 5%	1*	NICKOL (1967, 1969)
Acanthocephalus dirus	adult	*Notophthalmus viridescens* +	Maryland	?	?	VAN CLEAVE (1915), STILES & HASSALL (1984)
Acanthocephalus dirus	adult	*Necturus maculosus* +	Wisconsin	42 9%	6*	AMIN (1985)
Acanthocephalus dirus	adult	*Necturus maculosus* +	Wisconsin	100 0%	1*	AMIN (1985)
Fessisentis acutulus	adult	*Notophthalmus viridescens* + (123)	North Carolina	86 8%	0 64◆	VAN CLEAVE (1931), HOLL (1932)
Fessisentis fessus	adult	*Ambystoma talpoideum* +	Illinois	70%	?	BUCKNER & NICKOL (1979)
Fessisentis fessus	adult	*Siren intermedia* + (3)	Illinois	100 0%	5* (3-10)	LANDEWE (1963), DUNAGAN & MILLER (1973)
Fessisentis fessus	adult	*Siren intermedia* + (68)	Illinois	23 5%	(1-12)	ALTIG (1967), NICKOL (1972)
Fessisentis fessus	adult	*Siren intermedia* +	Louisiana	?	?	NICKOL (1972)
Fessisentis fessus	adult	*Siren intermedia* + (16)	Illinois	81 3%	(2-49)	NICKOL (1972)
Fessisentis fessus	adult	*Siren intermedia* + (24)	Illinois	100%	?	DUNAGAN & MILLER (1973)

Table I. (continued)

Species	Age class	Host	Location	Prevalence	Intensity*/ abundance◆	Source
Fessisentis friedi	adult	*Rana catesbeiana* + (12)	New Brunswick	8 3%	2*	This report
Fessisentis friedi	adult	*Rana pipiens* + (101)	New Brunswick	3.0%	1*	This report
Fessisentis friedi	adult	*Rana pipiens* (100)	New Brunswick	1.0%	1*	This report
Fessisentis friedi	adult	*Necturus maculosus* +	Ohio	?	?	Buckner & Nickol (1979)
Fessisentis necturorum	adult	*Ambystoma opacum**	Georgia	86 8%	3.9* (1-22)	Nickol & Heard (1973)
Fessisentis necturorum	adult	*Eurycea bislineata / longicauda**	Georgia	37 5%	1 3* (1-2)	Nickol & Heard (1973)
Fessisentis necturorum	adult	*Necturus beyeri* + (11)	Louisana	90.9%	?	Nickol (1967, 1969)
Fessisentis necturorum	adult	*Notophthalmus viridescens* + (6)	Georgia	16.7%	1*	Nickol & Heard (1973)
Fessisentis necturorum	adult	*Pseudotriton montanus**	Georgia	96.0%	3 4* (1-13)	Nickol & Heard (1973)
Fessisentis vancleavi	adult	*Eurycea longicauda* + (14)	Arkansas	?	?	Saltarelli (1977)
Fessisentis vancleavi	adult	*Eurycea multiplicata* + (19)	Oklahoma	42%	?	Malewitz (1956)
Fessisentis vancleavi	adult	*Eurycea multiplicata* + (8)	Arkansas	75%	?	Saltarelli (1977)
Fessisentis vancleavi	adult	*Eurycea multiplicata** +	Arkansas	?	?	Buckner & Nickol (1978)
Fessisentis vancleavi	adult	*Eurycea multiplicata* + (50)	Arkansas	4%	7 5*	McAllister et al. (1995*b*)
Fessisentis vancleavi	adult	*Eurycea tynerensis* + (73)	Oklahoma	13 7%	1 5* (1-3)	Hughes & Moore (1943)
Pomphorhynchus bulbicolli	adult	*Notophthalmus viridescens* + (138)	Massachusetts	0 7%	0 08◆	Rankin (1945)
Leptorhynchoides thecatus	adult	*Ambystoma tridactylum* + (11)	Tennessee	100%	(6-30)	Reiber (1941)
Leptorhynchoides thecatus	adult	*Ambystoma tridactylum* +	Tennessee	?	?	Lincicome & Van Cleave (1949)
Leptorhynchoides thecatus	adult	*Necturus maculosus* +	Indiana	?	?	Lincicome & Van Cleave (1949)
Centrorhynchus sp.	cystacanth	*Bufo fowleri* + (62)	North Carolina	1 6%	0 02◆	Brandt (.936)
Centrorhynchus sp.	cystacanth	*Pseudacris crucifer* + (60)	North Carolina	1 7%	0 02◆	Brandt (1936)
Centrorhynchus sp	cystacanth	*Pseudacris brimleyi* + (55)	North Carolina	7 3%	0 13◆	Brandt (1936)
Centrorhynchus sp	cystacanth	*Rana catesbeiana* + (33)	North Carolina	81 8%	13 9◆	Brandt (1936)
Centrorhynchus sp.	cystacanth	*Rana catesbeiana* + (38)	North Carolina	5.3%	0.13◆	Brandt (1936)
Centrorhynchus sp.	cystacanth	*Rana catesbeiana* + (30)	Virginia	33 3%	5 2◆	Campbell (1968)
Centrorhynchus sp.	cystacanth	*Rana catesbeiana* + (69)	Texas	2.9%	1*	Hollis (1972)
Centrorhynchus sp.	cystacanth	*Rana clamitans* + (29)	Virginia	24 1%	6.4◆	Campbell (1968)
Centrorhynchus sp	cystacanth	*Rana sphenocephala* + (60)	North Carolina	28 3%	2 6◆	Brandt (1936)
Centrorhynchus californicus	cystacanth	*Hyla regilla* +	California	4.6%	1*	Millzner (1924)
Centrorhynchus conspectus	cystacanth	*Desmognathus fuscus* + (54)	Louisana	3 7%	2*	Nickol (1969)
Centrorhynchus conspectus	cystacanth	*Desmognathus monticola* + (125)	North Carolina	1 6%	0 02◆	Goater et al. (1987)
Centrorhynchus conspectus	cystacanth	*Desmognathus quadramaculatus* + (115)	North Carolina	1 7%	0 02◆	Goater et al. (1987)
Centrorhynchus conspectus	cystacanth	*Plethodon glutinosus* + (67)	Louisana	3 0%	2*	Nickol (1969)
Centrorhynchus wardae	adult	*Rana clamitans* + (29)	Virginia	3.4%	0 03◆	Campbell (1968)
Neoechinorhynchus sp	adult	*Siren intermedia**	Illinois	?	?	Miller & Dunagan (1971) Dunagan & Miller (1973)
Neoechinorhynchus rutili	adult	*Rana catesbeiana* + (204)	New Brunswick	0 5%	3*	This report

Fessisentis acutulus (Van Cleave, 1931), while *Acanthocephalus acutulus* reported by NICKOL (1969) is assigned to *Acanthocephalus* sp. Material identified by RANKIN (1937) and DYER & BRANDON (1973) as *A acutulus* is no longer extant, and the identity of these worms is therefore unknown.

The 69 natural infections reported in Table I include encysted cystacanths (from the mesentery, or rarely muscle) and adult Acanthocephala (from the intestine). Experimental infections of *Macracanthorhynchus ingens* (LINSTOW, 1879) in *Rana pipiens* and of *Fessisentis fessus* Van Cleave, 1931 in *Ambystoma opacum* and *A. tigrinum* reported by MOORE (1946) and BUCKNER & NICKOL (1979) are not included in Table I. Cystacanths have been identified as *Centrorhynchus* sp., *C. californicus* Millzner, 1924 and *C. conspectus* Van Cleave & Pratt, 1940. *Centrorhynchus californicus* was described by MILLZNER (1924) from the mesentery of *Hyla regilla* but has not been reported since. Unfortunately, the type material appears to no longer exist (personal commmunications from J. R. LICHTENFELS, U.S. National Parasite Collection, J. P. DONAHUE, Natural History Museum of Los Angeles, E KOOLS, California Academy of Sciences and D. B. WAKE, Museum of Vertebrate Zoology, University of California).

The 25 North American amphibian cystacanth records are from both salamanders and anurans (56 % vs. 44 %). More than 75 % of these reports are from aquatic hosts. Although hosts such as *Bufo fowleri* and *Pseudacris* species are principally terrestrial outside the breeding season, amphibian cystacanth hosts are most commonly aquatic species. In Europe, unlike North America, there are few records of cystacanths parasitizing amphibians (SCHMIDT, 1985). Several extensive surveys of helminths in European amphibians have not revealed cystacanths parasitizing such hosts (HRISTOVSKI & LEES, 1973; PROKOPIC & KRIVANEC, 1975).

Nine species of adult Acanthocephala in six genera have been recorded as parasites in the intestines of North American amphibians. Records for *Pomphorhynchus bulbocolli* Linkins in Van Cleave, 1919, *Leptorhynchoides thecatus* (Linton, 1891), *Centrorhynchus wardae* Holloway, 1958 and *Neoechinorhynchus rutili* (Müller, 1780) are accidental infections in amphibians since these Acanthocephala are normally parasitic in fish or birds. Prevalences of these species in amphibians were mostly under 1 % and reports were often based on single or few worms. In addition, reports of *C. wardae* in *R. clamitans*, *L. thecatus* in *Amphiuma tridactylum* and *N. rutili* in *R. catesbeiana* are based on worms which were not sexually mature. *Acanthocephalus dirus* infections in *Necturus maculosus* appear peripheral to the usual infections in numerous piscine hosts. Although prevalences of infection were high, host sample sizes for these reports are too small on which to base any conclusions.

CAMPBELL (1968) provided the only previous North American report of an adult acanthocephalan in an anuran, *Centrorhynchus wardae* in *Rana clamitans*. RICHARDSON (1993) noted the strong resemblance between *C. wardae* and *C. conspectus* The host records for *F. friedi* in *R. catesbeiana* and *R. pipiens* presented here are the first reports of *Fessisentis* sp. parasitizing Anura. Among amphibians, aquatic salamanders are the most frequent hosts for *Fessisentis* species (NICKOL, 1969, 1972; NICKOL & HEARD, 1973; BUCKNER & NICKOL, 1979). In nine of 18 infections of amphibians with *Fessisentis* species, where information on prevalences is provided, rates are 70 % or greater, and *Fessisentis*

vancleavi and *F. necturorum* are only known as parasites of salamanders (Amin, 1980). Nonetheless, species of *Fessisentis* have not been encountered as widely in North American amphibians as has been *A. ranae* in European amphibians.

More than 80 % of North American adult acanthocephalan infections have been reported in salamanders from aquatic habitats. Similarly, Pearse (1932) found Acanthocephala in Japan restricted to salamanders from aquatic environments, suggesting this was because of a dependence on aquatic intermediate hosts. Nickol & Heard (1973) reported that *F. necturorum* parasitized only aquatic stages of salamander hosts. Adult Acanthocephala appear rarely to infect North American anurans or any terrestrial or semi-terrestrial amphibian. The accidental infection in *R. clamitans* reported by Campbell (1968), and the Acanthocephala records for *R. catesbeiana* and *R. pipiens* reported here, are the only cases of adult Acanthocephala parasitic in North American frogs. In contrast, *A. ranae* has been regularly reported from both European frogs and salamanders (Lees, 1962; Prokopic & Krivanec, 1975; Kuc & Sulgostowska 1988*a*), sometimes at prevalences of over 80 % (Kuc & Sulgostowska 1988*b*). Walton (1942) noted that *N. rutili* has been reported parasitic in *R. esculenta* from Europe.

Although Aho (1990) noted that few parasite surveys of amphibians have been comprehensive, it appears that helminth communities of both European salamanders and frogs regularly include adult Acanthocephala, whereas North American amphibian helminth communities do so infrequently.

Acknowledgements

Acanthocephalans reported here were collected during a survey of the helminths of bullfrogs, green frogs and leopard frogs in New Brunswick. I am grateful to T. J. Fletcher, C. Wagg, K. Rourke and T. Gomar for assistance in collecting frogs.

Literature cited

Aho, J. M. 1990. – Helminth communities of amphibians and reptiles: comparative approaches to understanding patterns and processes. *In*: G. W. Esch, A. O. Bush & J. M. Aho (eds.), *Parasite communities: patterns and processes*, New York, Chapman & Hall: 157-195.

Altig, R., 1967. Food of *Siren intermedia nettingi* in a spring-fed swamp in southern Illinois. *Am. Midl. Nat.*, **77**: 239-241.

Amin, O. M., 1980. *Fessisentis tichigenensis* sp. nov. (Acanthocephala: Fessisentidae) from Wisconsin fishes with a key to species. *J. Paras.*, **66**: 1039-1045.

----- 1985. Hosts and geographic distribution of *Acanthocephalus* (Acanthocephala: Echinorhynchidae) from North American freshwater fishes, with a discussion of relationships. *Proc. helm. Soc. Washington*, **52**: 210-220.

Bennett, H. J. & Humes, H. G. 1938. – Helminth parasites of *Amphiuma tridactylum* and *Siren lacertina* from Louisiana. *Louisiana Acad. Sci.*, **4**: 243-245.

Brandt, B. B., 1936. Parasites of certain North Carolina Salientia. *Ecol. Mon.*, **6**: 491-532.

Buckner, R. L. & Nickol, B. B. 1978. – Redescription of *Fessisentis vancleavi* (Hughes and Moore 1943) Nickol 1972 (Acanthocephala: Fessisentidae). *J. Paras.*, **64**: 635-637.

----- 1979. – Geographic variation among species of *Fessisentis* (Acanthocephala) and confirmation of the *Fessisentis fessus* life cycle. *J. Paras.*, **65**: 161-166.

CAMPBELL, R. A., 1968. A comparative study of the parasites of certain Salientia from Pocahontas State Park, Virginia. *Virginia J. Sci.*, **19**: 13-20.

DUNAGAN, T. T. & MILLER, D. M., 1973 – Some morphological and functional observations on *Fessus fessus* Van Cleave (Acanthocephala) from the dwarf salamander, *Siren intermedia* Le Conte. *Proc. helm. Soc. Washington*, **40**: 209-216.

DYER, W. G., 1983. – A comparison of the helminth fauna of two *Plethodon jordani* populations from different altitudes in North Carolina. *Proc. helm. Soc. Washington*, **50**: 257-260

DYER, W. G & BRANDON, R A , 1973. – Helminths from salamanders in Oklahoma and Missouri. *Herpetologica*, **29**: 371-373.

DYER, W. G, BRANDON, R. A. & PRICE, R. L., 1980. – Gastrointestinal helminths in relation to sex and age of *Desmognathus fuscus* (Green, 1818) from Illinois *Proc. helm. Soc Washington*, **47**: 95-99.

FOGLE, C L , 1960. – *The growth rate, reproductive cycle, movements, food habits, and parasitism of* Eurycea multiplicata griseogaster *in northwestern Arkansas, with notes on maintenance in captivity*. Unpublished M.S. thesis, Univ. of Arkansas, Fayetteville: 1-57.

GOATER, T. M., ESCH, G. W. & BUSH, A. O , 1987. Helminth parasites of sympatric salamanders: ecological concepts at infracommunity, component and compound community levels. *Am. Midl. Nat.*, **118**: 289-300.

HOLL, F J , 1932. – The ecology of certain fishes and amphibians with special reference to their helminths and linguatilid parasites. *Ecol. Mon.*, **2**: 84-107.

HOLLIS, P D , 1972 – A survey of parasites of the bullfrog, *Rana catesbeiana* Shaw, in central east Texas. *Southw. Nat.*, **17**: 198-200.

HRISTOVSKI, N. D & LEES, E , 1973. – The helminth fauna of *Rana temporaria* in relation to that of Europe generally. *Acta paras. iugosl.*, **4**: 93-98.

HUGHES, C R. & MOORE, G. A , 1943 – *Acanthocephalus van-cleavei*, a new echinorhynchid worm, from a salamander. *Am. Midl. Nat* , **29**: 724-729.

KUC, I & SULGOSTOWSKA, T., 1988*a*. – Helminth fauna of *Rana ridibunda* Pallas, 1771 from Goclawski Canal in Warszawa (Poland). *Acta paras. polon.*, **33**: 101-105.

----- 1988*b* – Helminth fauna of frogs in the forest of Kaminos near Warszawa. *Acta paras. polon.*, **33**: 267-272.

LANDEWE, J. E., 1963. – *Helminth and arthropod parasites of salamanders from southern Illinois*. Unpublished M.S. thesis, Southern Illinois University, Carbondale: 1-47.

LEES, E., 1962. – The incidence of helminth parasites in a particular frog population. *Parasitology*, **52**: 95-102

LINCICOME, D. R. & VAN CLEAVE, H. J., 1949. Distribution of *Leptorhynchoides thecatus*, a common acanthocephalan parasitic in fishes. *Am. Midl. Nat.*, **41**: 421-431.

MALEWITZ, T. D., 1956. – Intestinal parasitism of some mid-western salamanders *Am Midl Nat.*, **55**: 434-436.

MANN, D. R., 1932. – *The ecology of some North Carolina salamanders with special reference to their parasites*. Unpublished M.S. thesis, Duke Univ., Durham: 1-50.

MCALLISTER, C T , BURSEY, C. R., UPTON, S. J., TRAUTH, S. E. & CONN, D. B., 1995*a*. Parasites of *Desmognathus brimleyorum* (Caudata Plethodontidae) from the Ouachita Mountains of Arkansas and Oklahoma *J. helm. Soc. Washington*, **62**: 150-156.

MCALLISTER, C. T., TRAUTH, S. E. & BURSEY, C. R., 1995*b* – Metazoan parasites of the graybelly salamander, *Eurycea multiplicata griseogaster* (Caudata: Plethodontidae), from Arkansas. *J. helm. Soc. Washington*, **62**: 70-73.

MCALLISTER, C. T., UPTON, S. J. & TRAUTH, S. E., 1993. – Endoparasites of western slimy salamanders, *Plethodon albagula* (Caudata: Plethodontidae), from Arkansas. *J. helm Soc. Washington*, **60**: 124-126.

MCALPINE, D. F., in press. *Fessisentis acutulus* (Van Cleave, 1931) comb. nov. (Acanthocephala: Fessisentidae): a parasite of caudate amphibians in North America, with comments on the single North American report of *A ranae* (Schrank 1788). *J. helm. Soc. Washington*, **64**: in press.

MILLER, D. M & DUNAGAN, T T., 1971. – Studies on the rostellar hooks of *Macracanthorhynchus hirudinaceaus* (Acanthocephala) from swine. *Trans. am micr Soc.*, **90**: 329-335.

MILLZNER, R , 1924 – A larval acanthocephalid, *Centrorhynchus californicus*, sp. nov., from the mesentery of *Hyla regilla. Univ. Calif. Publ. Zool.*, **26**: 225-230.

MOORE, D. V , 1946 – Studies on the life history and development of *Macracanthorhynchus ingens* Meyer, 1933, with a redescription of the adult worm. *J. Paras* , **32**: 387-399.

NICKOL, B B , 1967. – *Fessisentis necturorum* sp n. (Acanthocephala. Fessisentidae), a parasite of the gulf coast waterdog, *Necturus beyeri. J. Paras.*, **53**: 1292-1294.

----- 1969 Acanthocephala of Louisiana Caudata with notes on the life history of *Centrorhynchus conspectus. Am. Midl. Nat.*, **81**: 262-265.

----- 1972 – *Fessisentis*, a genus of acanthocephalans parasitic in North American poikilotherms *J Paras.*, **58**: 282-289.

NICKOL, B. B. & HEARD, R. W., 1973. – Host-parasite relationships of *Fessisentis necturorum* (Acanthocephala: Fessisentidae). *Proc. helm. Soc. Washington*, **40**: 204-208.

ODLAUG, T. O., 1954. Parasites of some Ohio Amphibia. *Ohio J. Sci.*, **54**: 126-128.

PEARSE, A. S., 1932. – Parasites of Japanese salamanders *Ecology*, **13**: 135-152.

PROKOPIC, J. & KRIVANEC, K , 1975 Helminths of amphibians, their interactions and host-parasite relationships. *Acta Sci. nat. Brno*, **9**: 1-48.

RANKIN, J. S., 1937. – An ecological study of parasites of some North Carolina salamanders. *Ecol. Mon.*, **7**: 170-269

----- 1945 – An ecological study of the helminth parasites of amphibians and reptiles of western Massachusetts and vicinity. *J. Paras.*, **31**: 142-150.

REIBER, R J , 1941 – Nematodes of Amphibia and Reptilia 1. Reelfoot Lake Tennessee. *J. Tennessee Acad. Sci.*, **5**: 92-99.

RICHARDSON, D. J , 1993. – Acanthocephala of the Virginia opossum (*Didelphis virginiana*) in Arkansas, with notes on the life history of *Centrorhynchus wardae* (Centrorhynchidae). *Proc. helm. Soc. Washington*, **60**: 128-130.

SALTARELLI, W. A., 1977. – *Parasites of* Eurycea lucifuga *(Rafinesque)*, E longicauda melanopleura *(Green), and* E multiplicata *(Cope) (Amphibia: Plethodontidae) from northwestern Arkansas.* Unpublished M.S. thesis, Univ. of Arkansas, Fayetteville: 1-43.

SCHMIDT, G D., 1985. – Development and life cycles. *In*: D. W. T. CROMPTON & B. B NICKOL (eds.), *Biology of the Acanthocephala*, Cambridge, Cambridge Univ. Press: 273-305.

STILES, C. W. & HASSALL, A., 1894. – A preliminary catalogue of the parasites contained in the collections of the United States Bureau of Animal Industry, United States Army Medical Museum, Biology Department of the University of Pennsylvania (Coll Leidy) and in the coll. Stiles and coll. Hassall. *Veterinary Mag.*, **1**: 245-354.

VAN CLEAVE, H J , 1915 – Acanthocephala in North American Amphibia *J. Paras.*, **1**: 175-178.

----- 1931. – Acanthocephala in North American Amphibia. II. A new species of the genus *Acanthocephalus. Trans. am. micr. Soc.*, **50**: 46-47.

WALTON, A. C., 1942. – The Acanthocephala as parasites of Amphibia *Contr. biol. Lab. Knox. College*, **79**: 1-16.

WINTER, D A , ZAWADA, W. M. & JOHNSON, A. A , 1986. – Comparison of the symbiotic fauna of the family Plethodontidae in the Ouachita Mountains of western Arkansas. *Proc Arkansas Acad. Sci.*, **40**: 82-85

Corresponding editor: Jean-Louis ALBARET.